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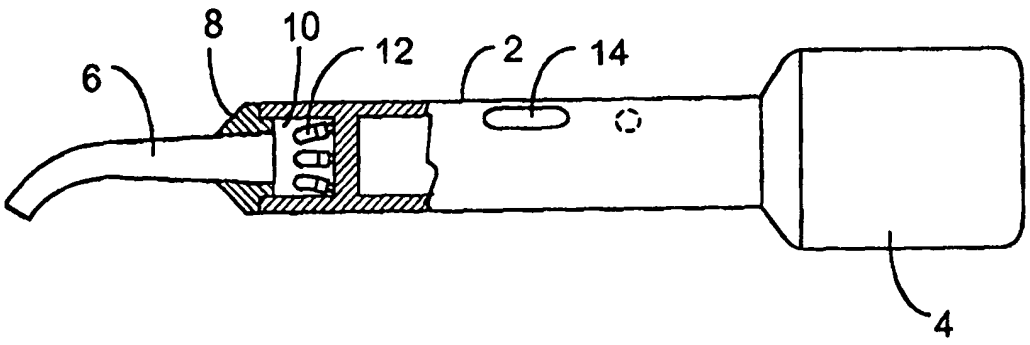
(54) Title: IRRADIATION APPARATUS FOR LIGHT CURING OF COMPOSITES, IN PARTICULAR FOR DENTAL USE



(57) Abstract

An irradiation apparatus for light curing of composites, in particular for dental use, comprises a handpiece with a light source in the form of a number of "blue" high effect diodes (LED) and is characterized in that the light diodes are mounted in close formation near a front end portion of the handpiece, radiating against the rear end of a light conductor rod projecting forwardly from this portion.

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Irradiation apparatus for light curing of composites, in particular for dental use.

The present invention concerns an irradiation apparatus for polymerisation of light-activated plastic, especially for the hardening of tooth fillings and fissure-sealing lacquer.

For this purpose, use has earlier been made of ultra-violet light, but for various reasons a change has been made to the use of visible light with correspondingly adapted plastic materials. However, considerable problems continue to be experienced with this technique, primarily because in order to achieve an acceptable depth effect, work must be carried out with a quite high power, which gives rise to an extremely unpleasant development of heat in the actual working area, i.e. in the hand tool used by the dentist for this purpose and an undesirable influence by the heat on the irradiated tooth. Use is typically made of a halogen lamp of the size up to 100 w, and it is quite normal for a cooling blower to be built into the handle of the tool itself, which makes the equipment voluminous and difficult to handle. Moreover, it is quite expensive, among other things because use must be made not only of a colour filter for selection of the most relevant light wavelength range, but also of a heat-reflecting filter for the protection of the patient.

After the arrival of the optical fibre technique, attempts have been made to get the whole of this apparatus placed at a distance from the working area, but it has proved that flexible optical fibres are vulnerable to the movements which must be made during the course of treatment. While optical fibre cables can distinguish themselves by a particularly good durability when they are laid out in a permanently-installed manner, this does not apply if they are exposed to regular operative movements. It is typical for a

break to occur in a progressive number of the fibres of which such a cable is built up, whereby the light conductivity characteristic is weakened to an increasing degree. To a certain extent, this could be compensated for, without inconvenience to the patient or the dentist, by the possibility of being able to make use of an external, even more powerful light equipment, but for several reasons this must be considered to be an unrealistic emergency solution. With this technique in mind, there must be awaited a development in the field of optical fibres such that it gives rise to conductors which are readily flexible and yet have a long life. There are excellent stiff optical fibre conductors in existence, but these will again simply require that the light source is placed in the handle of the tool, consequently with the problems of heat associated herewith.

It must thus be mentioned that there can be expectations that a newer type of light source, i.e. the so-called photo-diodes (LEDs), can with time be developed to such a degree of efficiency that they will find immediate application as "irradiation tips" in hand tools for the purpose discussed, such as already foreseen in EP-A-0 780 103. These diodes, which are already produced commercially for emission of blue light in a spectral range which almost corresponds with the area which is relevant here (470 nm ± 35 nm at 3 dB), distinguish themselves by a very low development of heat, and since they are also available in very small dimensions, typically with a diameter of 4-5 mm and a length of 8-9 mm, they will therefore e ideal for use in the present connection, when or if they can be developed for the emission of light of the necessary strength. However, here again there is a long way to go.

Moreover, it is also disclosed in said EP-A-0 780 103 that instead of a single diode, the "irradiation tip" can consist of a bundle of 3-5 [illegible]

lens can concentrate the emitted light towards the place of treatment. However, in principle this involves two problems, i.e. partly that the irradiation head hereby becomes inconveniently voluminous, and partly that even with the very latest technology it is not possible to achieve the necessary total light intensity with the use of only 3-5 diodes.

With the present invention, however, it has been ascertained that the diodes are now already developed as so-called "daylight diodes", primarily for use in various sign-posting situations, with such a considerable light intensity that 6-7 diodes together are enough to provide the light necessary for the present purpose, but it must be noted that this is when use is made of the special circumstance that it has shown that these diodes can be overloaded quite considerably within the relatively short periods which are involved in the treatments which are relevant here, i.e. an overloading of 2-300% in relation to the stated normal values. There can hereby be achieved a total light strength of more than the 8-10 candela (cd) which, for the time being, are a minimum for the necessary intensity for the hardening of the current plastic composites.

In that the diode dimensions can not be expected to be reduced, the problem will still thus prevail that a group of e.g. 5-8 diodes arranged in an irradiation tip will be inconveniently voluminous. In connection with the invention, however, it has been recognised that precisely with the use of the said stiff optical fibres it will be possible to configure the hand-tool in such a manner that the necessary diode group is placed in a suitably wide hand-grip part with light emission towards the rear end of a light conductor rod extending from said hand-grip, which thus via a possibly bent-out front end can conduct the total light to the place of treatment. Preferably, a selection will be made of diodes with a narrower irradiation angle (15°) and this will

des in the actual ring of diodes are brought to emit light at an angle in towards the said rear end of the light conductor rod for further conduction, it will not be necessary to make use of a convex lens.

While the ring of diodes will probably be larger than convenient for the thickness of an "irradiation tip", it can nevertheless be fully acceptable for incorporation in a broader handle part of the relevant tool when the result will be that the total light will, however, be transferred to the place of treatment via the fixed light conductor connection. This light conductor can thus be pivotable so that its bent-out tip can be turned out in different directions as required. However, the same can be achieved by the turning of the whole tool.

With the invention it has been found to be fully realistic to work with a power supply from a battery built into the tool, preferably of the rechargeable type. A typical current consumption for 7 diodes will be approx. 500 mA, approx. 2W, but the actual periods of use will hardly exceed 1 minute, so that a battery of reasonably small size will, for example, still be operative throughout the whole of a working day.

With these dental lacquering treatments, it is practical to make use of a relatively wide beam of light, and associated with the tool there can be two or more light-conducting attachments for replaceable mounting on the tool.

In the following, the invention will be described with reference to the drawing, in which

fig. 1 is a perspective view of a tool according to the invention, and

fig. 2 is a side view of the tool, partly in section.

The tool has a tubular hand-grip part 2 which at the rear has a replaceable battery housing 4, while at the

front it has a projecting, endwise bent-out light conductor rod 6 of the substantially stiff type, preferably based on optical fibres, mounted in a holder 8 for replaceable attachment to the hand-grip part. Immediately behind the part 6, 8, there is a lamp housing 10 in which are mounted a number of "blue" light diodes 12 pointing towards the end of the rod 6. In a preferred embodiment, use is made of seven diodes, i.e. a central diode with a surrounding ring of six diodes. These are configured with built-in reflectors, whereby it is not necessary to use an additional reflector.

The hand-grip part 2 has a display 14 for showing the setting of the activation time in seconds, and one or more operating buttons 16 for time adjustment and activation, and possibly for selection of a reduced number of diodes for use in connection with tasks where use can be made of light with reduced intensity. However, these buttons preferably consist of fixed touch-sensitive areas.

It must be noted that the total light intensity should be at least 8-10 candela (cd), preferably approx. 14 cd, i.e. for seven diodes an intensity of approx. 2 cd per diode will be required. It has been found possible for this to be achieved with diodes of the NSPB 500S type from Nichia Corporation, irradiation angle 15°.

The tool's internal power supply is configured as a constant current generator which, independently of temperature and battery condition, will ensure that the light gained from the diodes will be constant.

C L A I M S

1. Irradiation apparatus for light curing of composites with blue light, especially for dental use, comprising a hand piece with a light source in the form of a number of "blue" high-effect diodes (LED), c h a r a c t e r i z e d in that the light diodes are disposed in close formation near a front end part of the hand piece, radiating towards the rear end of a light conductor rod extending from said hand piece.

2. Apparatus according to claim 1, where the diodes appear in a number of 5-10.

3. Apparatus according to claim 1, where the light conductor rod is thinner than the circumference of the diode group.

4. Apparatus according to claim 1, where the diodes are battery-driven via a constant current generator.

5. Apparatus according to claim 1, where the hand piece has a battery housing for battery operation of the diodes.

6. Apparatus according to claim 1, where the hand piece has means for the selection of a reduced number of active diodes.

7. Apparatus according to claim 1, where the light conductor rod is removable and replaceable with one or more other light conductor rods with different thickness.

8. Apparatus according to claim 1, where the total irradiation strength amounts to at least 8-10 candela, preferably 12-16 candela.

9. Apparatus according to claim 1, where the power supply is arranged to drive the diodes with an effect which is several times the nominal working effect.

10. Apparatus according to claim 1, where the diodes are driven with a light strength of at least approx. 2 candela and with a radiation angle of 15°.

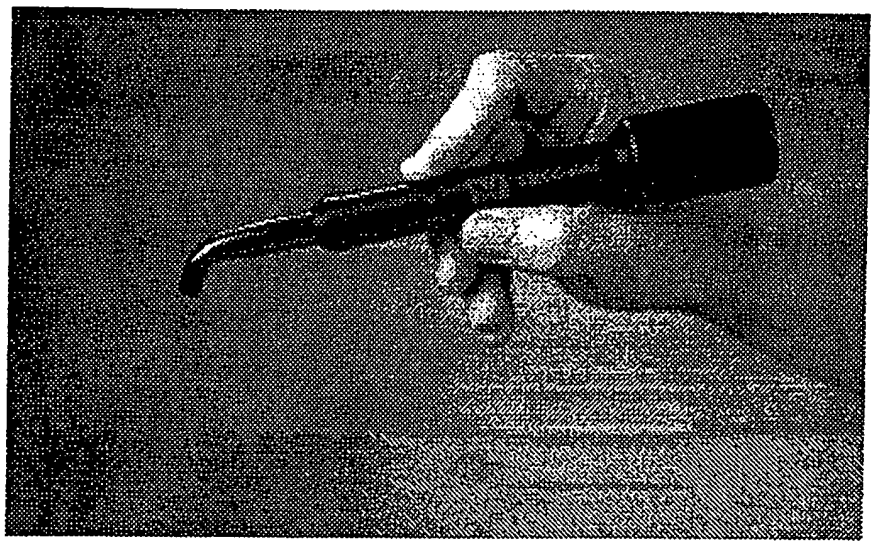

Fig.1

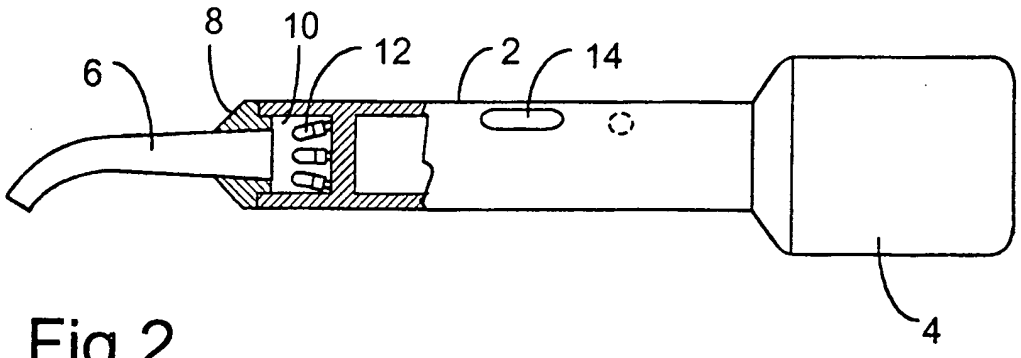

Fig.2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 99/00475

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: A61C 19/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9507731 A1 (EFOS CANADA INC.), 23 March 1995 (23.03.95), page 6, line 18 - line 25, figure 1, abstract --	1-10
X	WO 9736552 A1 (NULITE SYSTEMS INTERNATIONAL PTY. LTD.), 9 October 1997 (09.10.97), page 3, line 38 - page 4, line 13, figure 2, abstract --	1-10
A	EP 0755662 A1 (THERA PATENT GMBH & CO. KG GESELLSCHAFT FüR INDUSTIELLE SCHUTZRECHTE), 29 January 1997 (29.01.97), column 3, line 39 - column 4, line 5, figure 1 --	1-10

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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4 January 2000	28.02.2000
Name and mailing address of the ISA/	Authorized officer

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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P,X	WO 9935995 A1 (KERR CORPORATION), 22 July 1999 (22.07.99), figure 1, abstract -- --------	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

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International application No.
PCT/DK 99/00475

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		GB 2329756 A	31/03/99
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		GB 9806046 D	00/00/00
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